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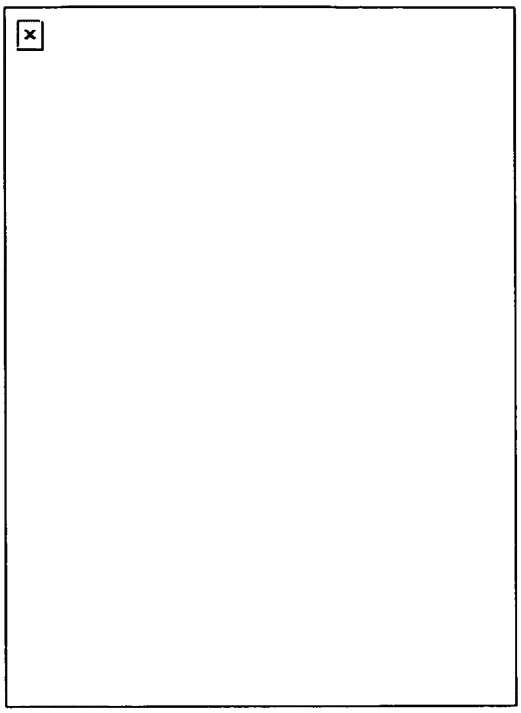
(54) PIEZOELECTRIC ELECTROACOUSTIC TRANSDUCER

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a piezoelectric electroacoustic transducer, capable of constituting a bimorph-type diaphragm by simple connecting structure by eliminating the mutual connection of a main surface electrode and internal electrode.

SOLUTION: Two or three piezoelectric ceramics layers 31 and 32 are laminated to form a laminated product, main surface electrodes 33 and 34 are formed on the front/rear surface of this laminated product, and an internal electrode 35 is formed between each of the layers 31 and 32. All the ceramics layers 31 and 32 are polarized in the same direction in the direction of thickness, and an alternating signal is impressed between the electrodes 33, 34 and the electrode 35 to allow the laminated product to generate bending oscillation as a whole.



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CLAIMS

[Claim(s)]

[Claim 1] Carry out the laminating of two-layer or the three-layer electrostrictive ceramics layer, and a layered product is formed. A principal plane electrode is formed in the front flesh-side principal plane of this layered product, and an internal electrode is formed between each ceramic layer. It is the piezo-electric mold electroacoustic transducer which polarization of all the ceramic layers is carried out in the same direction in the thickness direction, and is impressing an alternation signal between the above-mentioned principal plane electrode and an internal electrode, and is characterized by the above-mentioned layered product producing crookedness vibration as a whole.

[Claim 2] The above-mentioned internal electrode is a piezo-electric mold electroacoustic transducer according to claim 1 characterized by connecting with

the end-face electrode formed in the end face of a layered product, and impressing an alternation signal between the above-mentioned end-face electrode and two principal plane electrodes.

[Claim 3] It is the piezo-electric mold electroacoustic transducer according to claim 1 or 2 which the above-mentioned layered product consists of three-layer ceramic layers, and is characterized by the thickness of a middle ceramic layer being 50% - 80% of the thickness of the whole layered product.

[Claim 4] The above-mentioned layered product is a piezo-electric mold electroacoustic transducer according to claim 1 to 3 which carries out the laminating of the ceramic green sheet of two-layer or three layers through an electrode layer, is impressing an electrical potential difference to the principal plane inter-electrode which consisted of a sintered compact calcinated and obtained by coincidence, and was formed in the front flesh-side principal plane of the above-mentioned layered product, and is characterized by coming to polarize all ceramic layers in the same direction in the thickness direction.

[Claim 5] The above-mentioned layered product is formed in rectangle tabular, and it holds in the case where the above-mentioned layered product has opening on the inferior surface of tongue, and has a sound emission hole on the top face. Two sides which the above-mentioned layered product counters are supported by the supporting agent by the supporter formed in the medial-surface opposite section of the above-mentioned case. The closure of the clearance between other two sides of the above-mentioned layered product and the medial surface of the above-mentioned case is carried out with elastic encapsulant. The piezo-electric mold electroacoustic transducer according to claim 1 to 4 characterized by being closed with the back lid with which the opening of the above-mentioned case has the electrode for external connection connected to the principal plane electrode and internal electrode of the above-mentioned layered product.

[Claim 6] The above-mentioned layered product is formed in rectangle tabular, and the above-mentioned layered product has opening on the top face. It holds in the case where it has the electrode for external connection connected to the

principal plane electrode and internal electrode of the above-mentioned layered product. Two sides which the above-mentioned layered product counters are fixed to the supporter formed in the medial-surface opposite section of the above-mentioned case by the supporting agent. The piezo-electric mold electroacoustic transducer according to claim 1 to 4 which the closure of the clearance between other two sides of the above-mentioned layered product and the inside of the above-mentioned case is carried out with elastic encapsulant, and is characterized by closing top-face opening of the above-mentioned case by the top cover which has a sound emission hole.

[Claim 7] The above-mentioned layered product is formed in rectangle tabular, and it holds in the case where the above-mentioned layered product has opening on the inferior surface of tongue, and has a sound emission hole on the top face. Four sides of the above-mentioned layered product are fixed to the supporter formed in the medial surface of the above-mentioned case by the supporting agent. The piezo-electric mold electroacoustic transducer according to claim 1 to 4 characterized by being closed with the back lid with which the opening of the above-mentioned case has the electrode for external connection connected to the principal plane electrode and internal electrode of the above-mentioned layered product.

[Claim 8] The above-mentioned layered product is formed in rectangle tabular, and the above-mentioned layered product has opening on the top face. It holds in the case where it has the electrode for external connection connected to the principal plane electrode and internal electrode of the above-mentioned layered product. The piezo-electric mold electroacoustic transducer according to claim 1 to 4 with which four sides of the above-mentioned layered product are fixed to the supporter formed in the medial surface of the above-mentioned case by the supporting agent, and top-face opening of the above-mentioned case is characterized by being closed by the top cover which has a sound emission hole.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This inventions are piezo-electric mold electroacoustic transducers, such as a piezo-electric earphone, a piezo-electric sounder, a piezoelectric loudspeaker, and a piezo-electric buzzer, and a thing especially about the structure of the diaphragm.

[0002]

[Description of the Prior Art] Conventionally, the piezo-electric mold electroacoustic transducer is widely used for the piezo-electric earphone, the piezo-electric buzzer, etc. This kind of piezo-electric mold electroacoustic transducer has the common thing of the structure which stuck the circular metal plate on one side of a piezo-electric circular ceramic plate, constituted the uni-morph mold diaphragm, supported the periphery section of this diaphragm in the circular case, and closed opening of a case with covering. However, since in the case of a uni-morph mold diaphragm the ceramic plate which an outer diameter expands and contracts is pasted up on the metal plate which does not carry out a dimensional change and crookedness vibration is obtained by electrical-potential-difference impression, there is a fault of being small, the amount of displacement, i.e., sound pressure.

[0003] Then, the bimorph mold diaphragm of a laminated structure which consists of two or more electrostrictive ceramics layers is proposed (JP,61-205100,A). This diaphragm carried out the laminating of two or more ceramic green sheet and two or more electrodes, and the sintered compact calcinated and obtained by coincidence was used for it, and it has connected inter-electrode electrically by the through hole formed in the location which does not restrain vibration of a diaphragm. And compared with a uni-morph mold, the amount of big displacement, i.e., big sound pressure, can be obtained with constituting so that the 1st and 2nd oscillating fields arranged in order in the thickness direction may vibrate to hard flow mutually.

[0004]

[Problem(s) to be Solved by the Invention] However, after connecting the electrode of one principal plane, and one internal electrode mutually through the through hole and connecting the principal plane electrode of another side, and the internal electrode of another side mutually through a through hole as shown in Fig. 17 of the above-mentioned official report when crookedness vibration of the diaphragm which becomes in the case of the above-mentioned bimorph mold diaphragm (for example, a three-layer ceramic layer) tended to be carried out, it is necessary to impress an alternation electrical potential difference among both. Therefore, the complicated interconnect between a principal plane electrode and an internal electrode may have been needed, and it may have become cost quantity.

[0005] Moreover, also when performing polarization processing to the above-mentioned layered product, an electrical potential difference must be impressed and polarized between an internal electrode and the principal plane electrode of a front flesh side. For example, in the case of the diaphragm of a three-tiered structure, as shown in Fig. 14 of the above-mentioned official report, between a bond, this electrode for connection, and the principal plane electrode of a front flesh side, the high voltage is impressed and an internal electrode and two through holes through which it flows are polarized with the electrode for

connection. Thus, in the case of the conventional bimorph mold diaphragm, the internal electrode needed to be pulled out outside through the through hole for polarization processing, and there was a fault of needing the complicated processing of forming the electrode for connection etc.

[0006] Then, the purpose of this invention loses interconnect with a principal plane electrode and an internal electrode, and is to obtain the piezo-electric mold electroacoustic transducer which can constitute a bimorph mold diaphragm from easy connection structure. Moreover, other purposes are to obtain the piezo-electric mold electroacoustic transducer which can perform polarization processing easily.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, invention according to claim 1 Carry out the laminating of two-layer or the three-layer electrostrictive ceramics layer, and a layered product is formed. A principal plane electrode is formed in the front flesh-side principal plane of this layered product, and an internal electrode is formed between each ceramic layer. In the thickness direction, polarization of all the ceramic layers is carried out in the same direction, it is impressing an alternation signal between the above-mentioned principal plane electrode and an internal electrode, and the above-mentioned layered product offers the piezo-electric mold electroacoustic transducer characterized by producing crookedness vibration as a whole.

[0008] If an alternation electrical potential difference is impressed between a principal plane electrode and an internal electrode in the case of the layered product of this invention, the direction of electric field committed in the ceramic layer on a side front and a background will turn into hard flow in the thickness direction. On the other hand, all ceramic layers have turned to the direction of polarization in the same direction in the thickness direction. Electrostrictive ceramics has the property shrunken in the direction of a flat surface, if the direction of polarization and the direction of electric field are the same directions, and if the direction of polarization and the direction of electric field are hard flow,

it has the property extended in the direction of a flat surface. Therefore, when impressing the alternation electrical potential difference as mentioned above and the ceramic layer on a side front is prolonged, the ceramic layer on a background will be shrunken and a layered product will produce crookedness vibration as a whole. Since this amount of displacement becomes large compared with a uni-morph mold diaphragm, sound pressure also increases.

[0009] In this invention, if the principal plane electrode of a front flesh side is connected mutually and an alternation electrical potential difference is impressed between this and an internal electrode, since crookedness vibration can be generated, the complicated interconnect between a principal plane electrode and an internal electrode becomes unnecessary like before, structure becomes easy, and processing cost can be reduced.

[0010] It is desirable to connect an internal electrode with the end-face electrode formed in the end face of a layered product like claim 2, and to impress an alternation signal between the above-mentioned end-face electrode and two principal plane electrodes. In this case, exceptional processing of a through hole etc. is not needed.

[0011] Like claim 3, when the layered product consists of three-layer ceramic layers, it is desirable to make thickness of a middle ceramic layer into 50% - 80% of the thickness of the whole layered product. Although what is necessary is just to increase the number of laminatings of a layered product in order to raise sound pressure, when thickness is being fixed by resonance frequency, the number of laminatings cannot be increased freely, either. Since there is no potential difference between two internal electrodes in the case of the layered product of a three-tiered structure, an interlayer will not contribute to crookedness vibration but only the ceramic layer on a side front and a background will carry out crookedness vibration. A ceramic layer has so large that the thickness is thin the amount of displacement. Then, if the thickness of the whole layered product is set constant and an interlayer's thickness is relatively thickened to the thickness of a front lining, the thickness of the ceramic layer on the side front

which contributes to crookedness vibration, and a background will become thin relatively, and the big amount of displacement will be obtained. In addition, if an interlayer's thickness is enlarged too much, the thickness of a front lining will become thin too much, reinforcement will fall, and a big variation rate will not be obtained. Then, big sound pressure can be obtained by making an interlayer's thickness into 50% - 80% of the whole range.

[0012] It is impressing an electrical potential difference to the principal plane inter-electrode which consisted of a sintered compact with which a layered product's carries out the laminating of the ceramic green sheet of two-layer or three layers through an electrode layer, calcinates it to coincidence, and is obtained like claim 4, and was formed in the front flesh-side principal plane of a layered product, and it is desirable to polarize all ceramic layers in the same direction in the thickness direction. That is, although it is also possible to carry out two or more sheet laminating adhesion of the ceramic plate which calcinated beforehand and carried out polarization processing, and to obtain a layered product, now, thickness of a layered product cannot be made thin but sound pressure is small. On the other hand, if an electrode layer is carried out in between, and the laminating of the ceramic green sheet is carried out and it carries out coincidence baking, a very thin layered product can be obtained and high sound pressure can be obtained. And since the direction of polarization of each ceramic layer of a layered product has turned to the same direction, polarization processing becomes very easy that the polarization processing does not need to impress an electrical potential difference between an internal electrode and a principal plane electrode like before, and should just impress an electrical potential difference between the principal plane electrodes of a front flesh side.

[0013] When holding the above-mentioned layered product in housing and using as the sounding body like a piezo-electric earphone or a piezo-electric sounder, it can consider as structure [like] according to claim 5 to 8. That is, claims 5 and 6 are the examples suitable for the application as an earphone, and since they

correspond to the frequency of a large range, they are used in fields other than a resonance field. Therefore, since the vibrational energy of a layered product is comparatively small, only two sides which a layered product counters are supported in a case, and two sides have structure closed free [displacement with an elastic closure object] for others. On the other hand, claims 7 and 8 are the examples suitable for the application of a piezo-electric sounder etc., and since they correspond to the amount of Oto in single frequency, they are used in a resonance field. In this case, since the vibrational energy of a layered product is very large, it has structure which supported all four sides of a layered product in the case. Since the principal plane electrode and internal electrode of a layered product can be pulled out to the exterior of housing, without using lead wire, any structure can constitute them as a surface mounted device.

[0014]

[Embodiment of the Invention] Drawing 1 and drawing 2 show the 1st example of the piezo-electric mold electroacoustic transducer concerning this invention. This piezo-electric mold electroacoustic transducer consists of a disc-like diaphragm (layered product) 1, and the circular case 10 and the back lid 11 which held this diaphragm 1. The sound emission hole 12 was formed in the top face of a case 10, and the back lid 11 has pasted the opening. The terminals 13 and 14 for external connection were fixed to the position of symmetry of the periphery section of a case 10 in insert molding etc., and some terminals 13 and 14 are exposed inside a case 10. The electrode of a diaphragm 1 is electrically connected to the inside outcrop of terminals 13 and 14 by electroconductive glue 15 and 16. In addition, the closure of the clearance between the periphery section of diaphragms 1 other than the part which applied electroconductive glue 15 and 16, and a case 10 is carried out with elastic encapsulants (not shown), such as silicone rubber.

[0015] A diaphragm 1 carries out the laminating of the two-layer electrostrictive ceramics layers 2 and 3 which consist of PZT etc., as shown in drawing 3 and drawing 4 , the principal plane electrodes 4 and 5 are formed in the front flesh-

side principal plane of a diaphragm 1, and the internal electrode 6 is formed among the ceramic layers 2 and 3. As a thick wire arrow head shows to drawing 4 , in the thickness direction, polarization of the two ceramic layers 2 and 3 is carried out in the same direction.

[0016] In this example, the principal plane electrode 4 on a side front and the principal plane electrode 5 on a background are formed in a round shape a little smaller than the diameter of a diaphragm 1, and those drawer electrodes 4a and 5a are pulled out to the periphery edge of a diaphragm 1. It is mostly formed in a symmetry configuration with the principal plane electrodes 4 and 5, drawer electrode 6a of an internal electrode 6 is mostly pulled out with the above-mentioned drawer electrodes 4a and 5a to the position of symmetry, and the internal electrode 6 is connected to the end-face electrode 7 prepared in the end face. In addition, some end-face electrodes 7 are pulled out to the front rear face of a diaphragm 1. The above-mentioned drawer electrodes 4a and 5a are connected with a terminal 13 by electroconductive glue 15, and the end-face electrode 7 is connected with the terminal 14 by electroconductive glue 16. And crookedness vibration of the diaphragm 1 can be carried out by impressing a predetermined alternation electrical potential difference among terminals 13 and 14.

[0017] For example, if the electrical potential difference of minus and the electrical potential difference of plus to the other-end child 14 are impressed to one terminal 13, the electric field of the direction shown by the thin line arrow head of drawing 4 will arise. Since the ceramic layers 2 and 3 have the property shrunken in the direction of a flat surface if the direction of polarization and the direction of electric field are the same directions, and it has the property extended in the direction of a flat surface if the direction of polarization and the direction of electric field are hard flow, the ceramic layer 2 on a side front will be shrunken and the ceramic layer 3 on a background will be extended. Therefore, a diaphragm 1 is crooked so that a core may serve as a convex to a lower part. An alternation electrical potential difference, then a diaphragm 1 can produce

crookedness vibration for the electrical potential difference impressed to terminals 13 and 14 periodically, and the sound of big sound pressure can be generated by this.

[0018] The diaphragm 1 which consists of the above-mentioned configuration is manufactured by the following approaches. That is, an electrode layer is formed in the front face of the ceramic green sheet of a mother substrate condition at a pattern predetermined by technique, such as printing, the laminating of this one ceramic green sheet and the one ceramic green sheet which does not form the electrode layer is carried out, and it is stuck by pressure. Next, it pierces or cuts into the configuration corresponding to a diaphragm 1 from this layered product. Next, coincidence baking of punching or the cut layered product is carried out, and a sintering layered product is obtained. Next, a principal plane electrode is formed in the front flesh-side principal plane of a sintering layered product, and all the ceramic layers that constitute a layered product are polarized in the same direction in the thickness direction by impressing polarization voltage to these principal plane inter-electrode. Then, the end-face electrode 7 etc. is formed and a diaphragm 1 is obtained.

[0019] By the above-mentioned manufacture approach, after piercing the ceramic green sheet of the mother substrate condition by which the laminating was carried out in an individual configuration, it calcinated and polarization processing was carried out after that, but after calcinating the ceramic green sheet by which the laminating was carried out, polarization processing may be carried out in the state of a mother substrate, and you may cut into an individual configuration by after that. In this case, what is necessary is just to use well-known approaches, such as laser processing, in order to cut a sintered compact.

[0020] Drawing 5 and drawing 6 show the 2nd example of the piezo-electric mold electroacoustic transducer concerning this invention. Although the electrode of a diaphragm 1 was pulled out to the exterior in drawing 1 and drawing 2 using the terminals 13 and 14 fixed to the case 10, lead wire 20 and 21 is used in drawing 5 and drawing 6 . In this case, lead wire 20 and 21 is connected to the principal

plane electrode 5 and the end-face electrode 7 by the side of the rear face of a diaphragm 1 by cement 22 and 23, such as solder and electroconductive glue, respectively. Therefore, the principal plane electrodes 4 and 5 of a front flesh side may be mutually connected using electroconductive glue, and the principal plane electrodes 4 and 5 may be beforehand connected with an end-face electrode.

[0021] Drawing 7 and drawing 8 show the 3rd example of the piezo-electric mold electroacoustic transducer concerning this invention. This piezo-electric mold electroacoustic transducer consists of a rectangular diaphragm (layered product) 30, and the case 40 and the back lid 41 of the square shape which held this diaphragm 30. The sound emission hole 42 was formed in the top face of a case 40, and the back lid 41 has pasted the opening. The level difference-like supporters 42a and 42b are formed in the medial surface of two sides which a case 40 counters, and two sides by the side of the shorter side of a diaphragm 30 are supported by the supporting agents 43a and 43b, such as adhesives, on these supporter 42a and 42b. The braking hole 48 is formed in a different side face from the side face in which the supporters 42a and 42b of a case 40 were formed. Moreover, the closure of the clearance between two sides and cases 40 by the side of the long side of a diaphragm 30 is carried out with the elastic encapsulants 44a and 44b, such as silicone rubber. The electrodes 45a and 45b for external connection are formed in the both-ends table rear face of the back lid 41, and the electrodes 45a and 45b of a front flesh side have flowed mutually through the inside of the through hole slots 46a and 46b formed in the both-ends side edge of the back lid 41.

[0022] While the electrodes 45a and 45b for external connection and the electrode of a diaphragm 30 are mutually connected by slushing electroconductive glue 47a and 47b from the through hole slots 46a and 46b as shown in drawing 8 after pasting up the back lid 41 on the opening of a case 40, the through hole slots 46a and 46b are closed. Thereby, a piezo-electric mold electroacoustic transducer is completed.

[0023] As shown in drawing 9 and drawing 10 , as for the diaphragm 30 of this example, the laminating of the two-layer electrostrictive ceramics layers 31 and 32 is carried out, the principal plane electrodes 33 and 34 are formed in the front flesh-side principal plane of a diaphragm 30, and the internal electrode 35 is formed among the ceramic layers 31 and 32. As a thick wire arrow head shows to drawing 10 , in the thickness direction, polarization of the two ceramic layers 31 and 32 is carried out in the same direction.

[0024] In this example, the principal plane electrode 33 on a side front and the principal plane electrode 34 on a background are the shorter sides and these width of face of a diaphragm 30, and are formed a little shorter than a long side, and that end is connected to the end-face electrode 36 formed in one shorter side side edge side of a diaphragm 30. Therefore, the principal plane electrodes 33 and 34 of a front flesh side are connected mutually. The internal electrode 35 was mostly formed in the symmetry configuration with the principal plane electrodes 33 and 34, it is separated from the end of an internal electrode 35 of the internal electrode with the above-mentioned end-face electrode 36, and the other end is connected to the end-face electrode 37 formed in the shorter side side edge side of another side of a diaphragm 30. In addition, the end-face electrode 37 and the flowing narrow width auxiliary electrode 38 are formed in the vertical side of the shorter side side edge section of another side of a diaphragm 30.

[0025] The above-mentioned end-face electrode 36 or the principal plane electrode 34 on a background is connected with electrode 45a for external connection by electroconductive glue 47a like drawing 8 , and the end-face electrode 37 is connected with electrode 45b for external connection by electroconductive glue 47b. And crookedness vibration of the diaphragm 30 can be carried out in die-length bending mode by impressing a predetermined alternation electrical potential difference among the electrodes 45a and 45b for external connection. That is, crookedness vibration can be carried out, being able to use the shorter side side both ends of a diaphragm 30 as the supporting point,

and being able to use the center section of the longitudinal direction as a maximum amplitude point.

[0026] Since only a core serves as a maximum amplitude point, in the case of a circular diaphragm 1 like the 1st example, the displacement volume is small, and sound conversion efficiency is comparatively low to it. Moreover, since the perimeter of a diaphragm 1 is restrained, a radius dimension will become large, if a frequency tends to become high and it is going to obtain the piezo-electric diaphragm of a low frequency. On the other hand, since in the case of a rectangle diaphragm 30 like the 3rd example a maximum amplitude point meets the center line of the die-length direction and exists, the displacement volume is large and high sound conversion efficiency can be acquired. Moreover, although the die-length direction both ends are fixed, since a diaphragm 30 can displace a part in the meantime freely with the elastic encapsulants 44a and 44b, it can obtain a low frequency compared with a circular diaphragm. On the contrary, a dimension can be miniaturized if the same frequency is obtained.

[0027] Drawing 11 shows the 4th example of a diaphragm which is a modification of drawing 10 . Although drawing 10 showed the example whose internal electrode 35 is a partial electrode, in drawing 11 , it considers as a whole surface electrode. In this case, since the internal electrode 35 is prolonged in the end-face electrode 36 side, there is a possibility that an internal electrode 35 and the end-face electrode 36 may flow. Then, an insulating layer 39 is first formed in the end face of diaphragm 30', and the end-face electrode 36 which makes it flow through the principal plane electrodes 33 and 34 of a front flesh side is formed on it. Thereby, even when an internal electrode 35 is used as a whole surface electrode, an internal electrode 35 and the principal plane electrodes 33 and 34 can be insulated certainly.

[0028] Drawing 12 shows the 5th example of a diaphragm. The diaphragm 50 of this example carries out the laminating of the three-layer electrostrictive ceramics layers 51-53, the principal plane electrodes 54 and 55 are formed in the front rear face of a diaphragm 50, and internal electrodes 56 and 57 are formed among

each ceramic layers 51-53. As a thick wire arrow head shows, in the thickness direction, polarization of the three ceramic layers 51-53 is carried out in the same direction.

[0029] The principal plane electrodes 54 and 55 of this example are the shorter sides and these width of face of a diaphragm 50 like drawing 10 R> 0, and are formed a little shorter than a long side, and that end is connected to the end-face electrode 58 formed in one shorter side side edge side of a diaphragm 50. Therefore, the principal plane electrodes 54 and 55 of a front flesh side are connected mutually. It is separated from the end of internal electrodes 56 and 57 with the end-face electrode 58, and the other end is connected to the end-face electrode 59 formed in the shorter side side edge side of another side of a diaphragm 50. Therefore, internal electrodes 56 and 57 are also connected mutually. In addition, the end-face electrode 59 and narrow width auxiliary-electrode 59a through which it flows are formed in the vertical side of the shorter side side edge section of another side of a diaphragm 50.

[0030] For example, if the electrical potential difference of minus and the electrical potential difference of plus in the end-face electrode 59 are impressed to the end-face electrode 58, the electric field of the direction shown by the thin line arrow head of drawing 12 will arise. Since the internal electrodes 56 and 57 located in the both sides of the ceramic layer 52 which is an interlayer at this time are the same potentials, electric field do not produce them. Since the direction of polarization and the direction of electric field are the same directions, the ceramic layer 51 on a side front is shrunken in the direction of a flat surface, and since the direction of polarization and the direction of electric field are hard flow, the ceramic layer 52 on a background is extended in the direction of a flat surface. And an interlayer 52 is not expanded and contracted. Therefore, a diaphragm 50 is crooked so that it may become a convex to a lower part. If an alternation electrical potential difference is impressed between the end-face electrode 58 and 59, a diaphragm 50 can produce crookedness vibration periodically and can generate the sound of big sound pressure by this. In addition, in drawing 12 ,

although internal electrodes 56 and 57 were used as the partial electrode, it is good also as a whole surface electrode like drawing 11 .

[0031] It is the same as that of the manufacture approach of the diaphragm 1 of two-layer structure which also showed the above manufacture approaches of the diaphragm 50 of a three-tiered structure in drawing 4 . That is, an electrode layer is formed in the front face of the ceramic green sheet of a mother substrate condition at a pattern predetermined by technique, such as printing, the three-sheet laminating of this ceramic green sheet is carried out, and it is stuck by pressure. It pierces or cuts into the configuration corresponding to a diaphragm 50 from this layered product, coincidence baking of this punching or cut layered product is carried out, and a sintering layered product is obtained. Next, the principal plane electrodes 54 and 55 are formed in the front rear face of a sintering layered product, and all the ceramic layers 51-53 that constitute a layered product are polarized in the same direction in the thickness direction by impressing polarization voltage to these principal plane inter-electrode. Then, a diaphragm 50 is obtained by forming the end-face electrodes 58 and 59 etc. Since what is necessary is just not to connect internal electrodes 56 and 57 and the principal plane electrodes 54 and 55 mutually on the occasion of polarization in this case, and to impress an electrical potential difference between the principal plane electrode 54 of a front flesh side, and 55, polarization processing is easy.

[0032] Drawing 13 shows the 6th example of a diaphragm. Although the example of drawing 12 R> 2 showed the example whose three-layer ceramic layers 51-53 are the same thickness mostly, in drawing 13 , the middle ceramic layer 52 is thickened compared with the ceramic layers 51 and 53 of a front flesh side. As for especially the thickness of the middle ceramic layer 52, it is desirable to carry out to 50% - 80% of the thickness of whole diaphragm 50'. In addition, since other structures are the same as that of drawing 12 , duplication explanation is omitted.

[0033] Drawing 14 shows change of the sound pressure when changing the rate

of the thickness of the middle ceramic layer 52. An axis of ordinate is the ratio of the sound pressure when setting sound pressure of the diaphragm (refer to drawing 10) of two-layer structure to 1, and an axis of abscissa expresses the rate of the thickness of the middle ceramic layer 52 to the thickness of whole diaphragm 50'. In addition, sound pressure was measured on the conditions that applied voltage is certain, uniformly [the thickness of whole diaphragm 50'].

[0034] It turns out that sound pressure rises compared with two-layer in the case of three layers so that clearly from drawing 14 . Moreover, when an interlayer's thickness is made into 50% - 80% of the whole compared with the case (33%) where all three layers are the same thickness, sound pressure rises further. When an interlayer's thickness is especially made into 60% - 70% of the whole, the greatest sound pressure (it compares with two-layer and they are 1.6 times) can be obtained. Therefore, when the number of laminatings has constraint, sound pressure can be raised by enlarging an interlayer's thickness to the maximum, lessening the number of laminatings (three layers).

[0035] Drawing 15 - drawing 17 are the 7th example of the piezo-electric mold electroacoustic transducer concerning this invention, and show the example constituted as a piezo-electric earphone of a surface mount mold. This piezo-electric earphone consists of a diaphragm (layered product) 30 of a profile and a rectangle, a case 60 of the square shape which held this diaphragm 30, and a top cover 68 that has the sound emission hole 69. Since the diaphragm 30 is the same as that of what was shown in drawing 9 and drawing 10 , it has attached the same sign. A case 60 is formed with heat resistant resin, such as LCP (liquid crystal polymer), SPS (syndiotactic polystyrene), PPS (polyphenylene sulfide), and epoxy, and the top cover 68 is also formed with a heat-resistant ingredient or ceramics, such as a liquid crystal polymer or glass epoxy. Opening 61 was formed in the top face of a case 60, and the top cover 68 has pasted this top-face opening 61. The level difference-like supporters 62a and 62b are formed in the medial surface of two sides which a case 60 counters, and insert molding of the electrodes 63a and 63b for external connection is carried out so that it may

expose to the top face of these supporters 62a and 62b, and the lateral surface of a case 60. It consists of metal terminals which consist of Au, a Cu alloy which performed Sn plating, Fe, etc. as these electrodes 63a and 63b for external connection, for example. The braking hole 64 is formed in a different side face from the side face in which the supporters 62a and 62b of a case 60 were formed.

[0036] Two sides by the side of the shorter side of a diaphragm 30 are supported by the supporting agents 65a and 65b, such as adhesives, on supporter 62a and 62b. Moreover, the closure of the clearance between two sides and cases 60 by the side of the long side of a diaphragm 30 is carried out with the elastic encapsulants 66a and 66b, such as silicone rubber. And the end-face electrodes 36 and 37 prepared in two sides by the side of the shorter side of a diaphragm 30 are electrically connected with the electrodes 63a and 63b for external connection exposed to the top face of Supporters 62a and 62b by conductive paste 67a and 67b, respectively. In addition, it is better to perform it, after spreading of supporting agents 65a and 65b and the elastic encapsulants 66a and 66b pastes up a diaphragm 30 and the electrodes 63a and 63b for external connection by conductive paste 67a and 67b. And heat hardening of conductive paste 67a and 67b, supporting agents 65a and 65b, and the elastic encapsulants 66a and 66b may be performed to coincidence.

[0037] Drawing 18 is the 8th example of the piezo-electric mold electroacoustic transducer concerning this invention, and is the modification of the example shown in drawing 15 - drawing 17 . In this example, it was not inserted to a case 60, and the electrodes 63a and 63b for external connection insert in hole 60a of a case 60 the metal terminal formed in another object, and paste up. Since other structures are the same as that of drawing 15 R> 5 - drawing 17 , they give the same sign to the same components, and omit explanation.

[0038] Drawing 19 - drawing 21 are the 9th example of the piezo-electric mold electroacoustic transducer concerning this invention, and show the example constituted as surface mount die parts. In this example, it replaces with the electrodes 63a and 63b for external connection which consist of an insertion

terminal in drawing 15 - drawing 17 , and considers as the electrode layers 63c and 63d formed by the dry type galvanizing methods, such as the non-electrolyzed wet galvanizing method or a spatter. In this example, from the external surface of the flank which formed the supporters 62a and 62b of a case 60, electrode layers 63c and 63d are missing from the top face of Supporters 62a and 62b, and are formed continuously. Since other configurations are the same as that of the thing of drawing 15 - drawing 17 , they give the same sign to the same components, and omit explanation.

[0039] In addition, in the example shown in drawing 15 - drawing 21 , it is possible as a diaphragm not only the diaphragm 30 shown in drawing 9 and drawing 10 but diaphragm 30' shown in drawing 11 , drawing 12 , and drawing 13 and to also use 50 and 50'.

[0040] Drawing 22 is the 10th example of the piezo-electric mold electroacoustic transducer concerning this invention. This example is a modification of the example shown in drawing 7 , gives the same sign to the same part as drawing 7 , and omits explanation. Drawing 22 is the perspective view seen from the background, and the level difference-like supporter 42 is formed in the medial-surface perimeter of case 40'. The top face of these supporters 42 is formed in the same height, and the four-side perimeter of a diaphragm 30 is supported by the supporting agents 43, such as adhesives, on the supporter 42. Although it is used as a sound producing device in the single frequency of for example, a piezo-electric sounder etc. and the perimeter of a diaphragm 30 is restrained by the supporting agent 43, by using a diaphragm 30 in a resonance field, this example can be excited strongly and can obtain the amount of Oto.

[0041] Drawing 23 is the 11th example of the piezo-electric mold electroacoustic transducer concerning this invention. This example has the almost same structure as the example shown in drawing 15 - Fig. 1717 , gives the same sign to drawing 15 - Fig. 1717 and an intersection, and omits explanation. In this example, the level difference-like supporter 62 is formed in the medial-surface perimeter of the case 60 of a square shape, and all four sides of a diaphragm 30

are supported by the supporting agents 65, such as adhesives, to the supporter 62. This example is also an example used as a sound producing device in the single frequency of a piezo-electric sounder etc., and a diaphragm 30 is used in a resonance field.

[0042] This invention is not limited to the above-mentioned example, and can be variously changed in the range which does not deviate from the meaning of this invention. Although an internal electrode and the flowing end-face electrode are formed in the end face of a diaphragm and it was made to pull out to the exterior through this end-face electrode in the above-mentioned example, it does not restrict to this. That is, an internal electrode may be pulled out to the exterior through a through hole like JP,61-205100,A, and you may pull out to the exterior through slit-like a slot or a hole. Although the manufacture approaches of 50 and 50' are the diaphragms 1 and 30 of the above-mentioned example, 30', and a thing that carries out polarization processing of this sintering layered product for a ceramic green sheet through an electrode layer two sheets or after carrying out a three-sheet laminating, carrying out coincidence baking of this layered product and obtaining a sintering layered product, they may be replaced with this approach and may carry out laminating adhesion of two sheets or the three electrostrictive ceramics plates which calcinated beforehand and carried out polarization processing. however, since the thickness of a diaphragm is boiled markedly, and the manufacture approach of the former calcinated behind a laminating can make it thin compared with the approach of the latter which carries out the laminating of what was calcinated beforehand and can enlarge sound pressure, it can obtain the diaphragm the direction of the former manufacture approach excelled [diaphragm] in sound conversion efficiency The diaphragm of this invention may stick reinforcement sheets, such as a metal film and a resin sheet, on one side of what [not only] consisted of only electrostrictive ceramics layers but a layered product. However, this reinforcement sheet is for preventing the crack of a layered product etc. unlike the metal plate of a uni-morph mold diaphragm, and what does not check

crookedness vibration of a layered product is desirable.

[0043]

[Effect of the Invention] By the above explanation, according to invention according to claim 1, a principal plane electrode is formed in the front rear face of a layered product which consists of two-layer or a three-layer electrostrictive ceramics layer so that clearly. Since the internal electrode was formed between each ceramic layer and all the ceramic layers were polarized in the same direction in the thickness direction The ceramic layer on a side front and a background will expand and contract to hard flow, and if an alternation signal is impressed between a principal plane electrode and an internal electrode, a layered product will produce crookedness vibration as a whole. Since this amount of displacement becomes large compared with a uni-morph mold diaphragm, sound pressure also increases. Moreover, since polarization of all the ceramic layers is carried out in the same direction in the thickness direction, the complicated interconnect between the principal plane electrodes and internal electrodes like before is unnecessary, structure is [that what is necessary is just to impress an alternation signal between a principal plane electrode and an internal electrode] easy, and a manufacturing cost can be reduced.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the appearance perspective view of the 1st example of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 2] It is drawing of longitudinal section of the piezo-electric mold electroacoustic transducer shown in drawing 1 .

[Drawing 3] It is the perspective view of the diaphragm used for the piezo-electric mold electroacoustic transducer of drawing 1 .

[Drawing 4] It is drawing of longitudinal section of the diaphragm shown in drawing 3 .

[Drawing 5] It is the appearance perspective view of the 2nd example of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 6] It is drawing of longitudinal section of the piezo-electric mold electroacoustic transducer shown in drawing 5 .

[Drawing 7] It is the decomposition perspective view which looked at the 3rd example of the piezo-electric mold electroacoustic transducer concerning this invention from the background.

[Drawing 8] It is the sectional view of the piezo-electric mold electroacoustic transducer of drawing 7 .

[Drawing 9] It is the perspective view of the diaphragm used for the piezo-electric mold electroacoustic transducer of drawing 7 .

[Drawing 10] It is the sectional view of the diaphragm of drawing 9 .

[Drawing 11] It is the sectional view of the 4th example of the diaphragm concerning this invention.

[Drawing 12] It is the sectional view of the 5th example of the diaphragm concerning this invention.

[Drawing 13] It is the sectional view of the 6th example of the diaphragm concerning this invention.

[Drawing 14] It is the property Fig. showing the relation between the thickness of

the interlayer of the piezo-electric mold electroacoustic transducer using the diaphragm shown in drawing 13 , and sound pressure.

[Drawing 15] It is the perspective view of the 7th example of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 16] It is the decomposition perspective view of the piezo-electric mold electroacoustic transducer shown in drawing 15 .

[Drawing 17] It is the A-A line sectional view of drawing 15 .

[Drawing 18] It is the decomposition perspective view of the 8th example of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 19] It is the perspective view of the 9th example of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 20] It is the decomposition perspective view of the piezo-electric mold electroacoustic transducer shown in drawing 19 .

[Drawing 21] It is the B-B line sectional view of drawing 19 .

[Drawing 22] It is the decomposition perspective view of the 10th example of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 23] It is the decomposition perspective view of the 11th example of the piezo-electric mold electroacoustic transducer concerning this invention.

[Description of Notations]

1, 30, 30', 50, 50' Diaphragm

2, 3, 31, 32, 51-53 Ceramic layer

4, 5, 33, 34, 54, 55 Principal plane electrode

6, 35, 56, 57 Internal electrode

10 60 Case

11 [ ] Back Lid

62a, 62b Supporter

63a, 63b Electrode for external connection

65a, 65b Supporting agent

66a, 66b Elastic encapsulant

67a, 67b Conductive paste

68 [ ] Top Cover

69 [ ] Sound Emission Hole

[Translation done.]

* NOTICES *

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damages caused by the use of this translation.

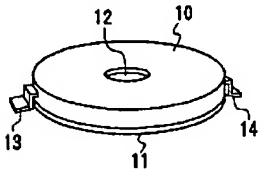
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

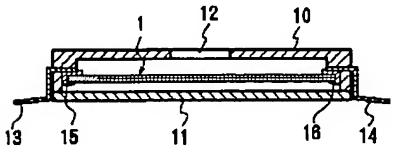
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



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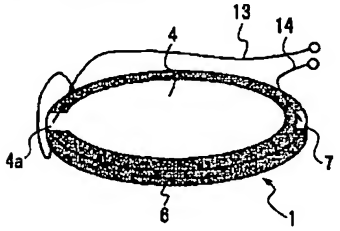

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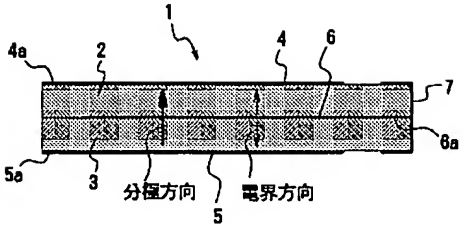

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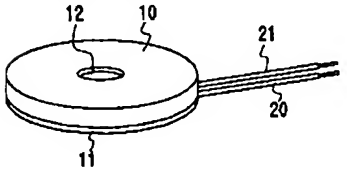

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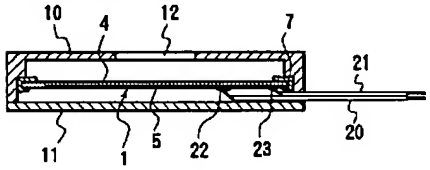

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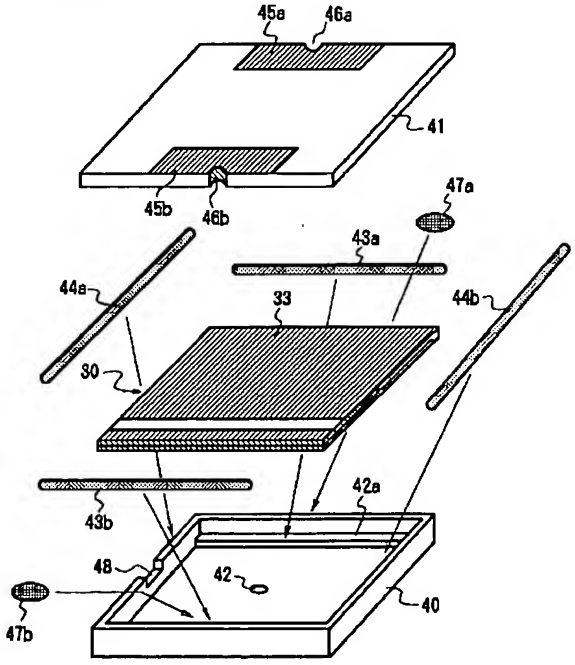

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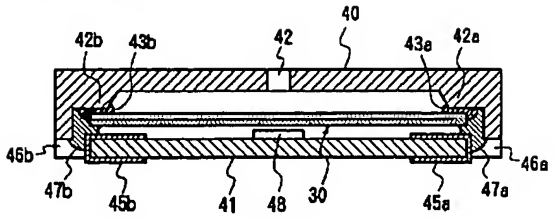

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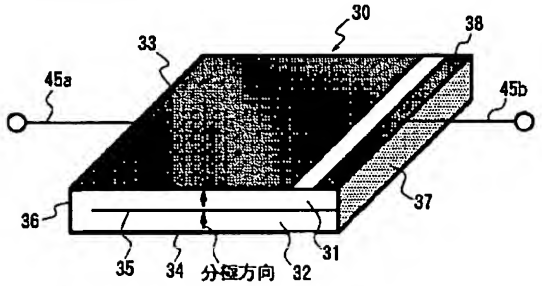

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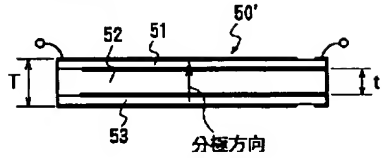

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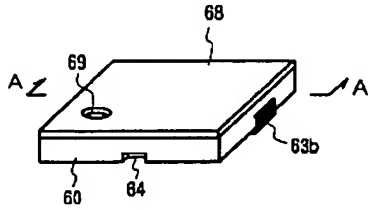

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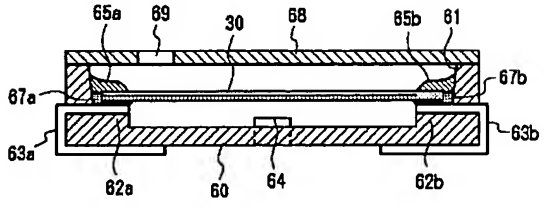

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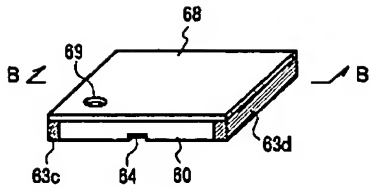

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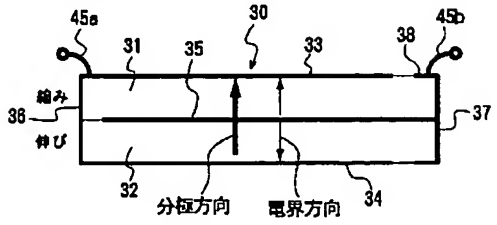

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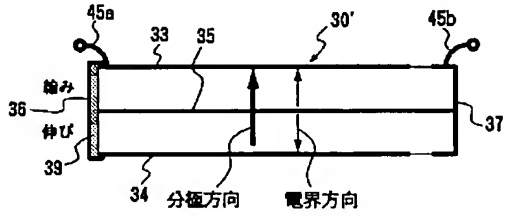

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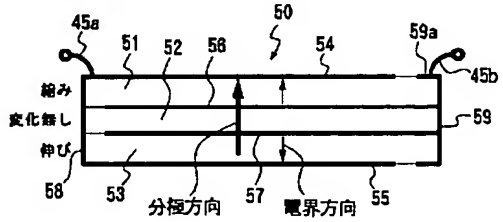

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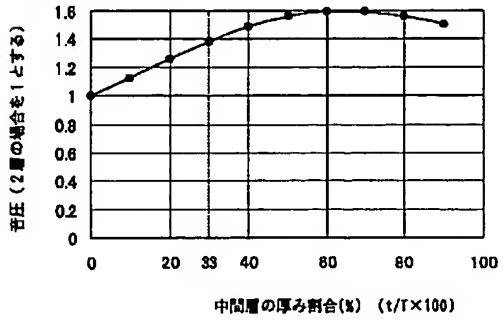

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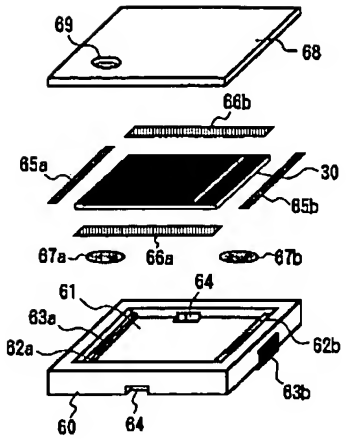

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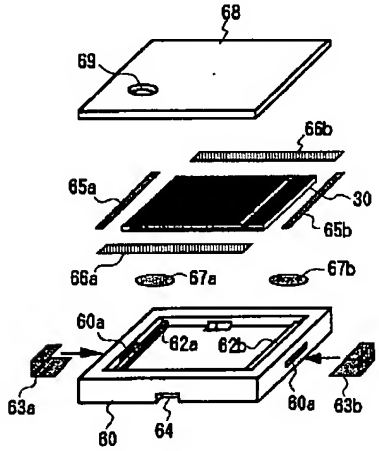

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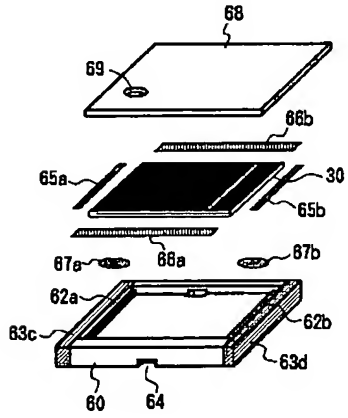

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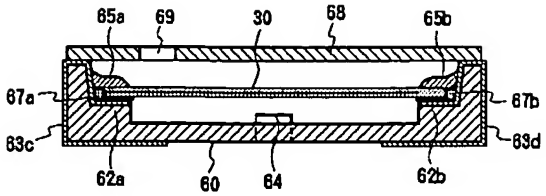

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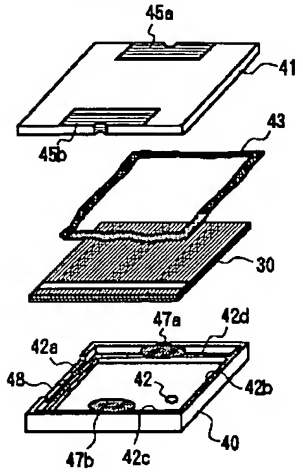
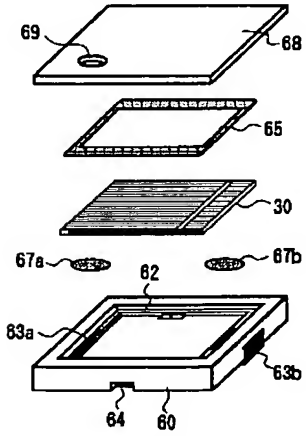


[Drawing 23]



[Translation done.]

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			Ｃ	

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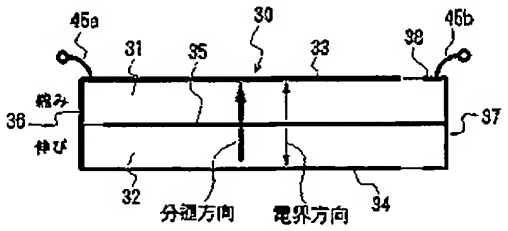
最終頁に続く

(54)【発明の名称】　圧電型電気音響変換器

(57)【要約】
【課題】主面電極と内部電極との相互接続をなくし、簡単な接続構造でバイモルフ型振動板を構成できる圧電型電気音響変換器を得る。
【解決手段】２層または３層の圧電セラミックス層３１、３２を積層して積層体が形成され、この積層体の表裏面には主面電極３３，３４が形成され、各セラミックス層３１，３２の間には内部電極３５が形成される。すべてのセラミックス層３１、３２は厚み方向において同一方向に分極されており、主面電極３３，３４と内部電極３５との間に交番信号を印加することで、積層体は全体として屈曲振動を生じる。



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【特許請求の範囲】

【請求項１】２層または３層の圧電セラミックス層を積層して積層体が形成され、この積層体の表裏主面には主面電極が形成され、各セラミックス層の間には内部電極が形成され、すべてのセラミックス層は厚み方向において同一方向に分極されており、上記主面電極と内部電極との間に交番信号を印加することで、上記積層体は全体として屈曲振動を生じることを特徴とする圧電型電気音響変換器。

【請求項２】上記内部電極は積層体の端面に形成された端面電極と接続され、上記端面電極と２つの主面電極との間に交番信号が印加されることを特徴とする請求項１に記載の圧電型電気音響変換器。

【請求項３】上記積層体は３層のセラミックス層で構成され、中間のセラミックス層の厚みは、積層体の全体の厚みの５０％～８０％であることを特徴とする請求項１または２に記載の圧電型電気音響変換器。

【請求項４】上記積層体は電極膜を介して２層または３層のセラミックグリーンシートを積層し、同時に焼成して得られる焼結体よりなり、上記積層体の表裏主面に形成された主面電極間に電圧を印加することで、すべてのセラミックス層を厚み方向において同一方向に分極してなることを特徴とする請求項１ないし３のいずれかに記載の圧電型電気音響変換器。

【請求項５】上記積層体は矩形板状に形成され、上記積層体が、下面に開口部を有し上面に放音穴を有するケースに収容され、上記積層体の対向する２辺が、上記ケースの内側面対向部に形成された支持部に支持剤により支持され、上記積層体の他の２辺と上記ケースの内側面との間の隙間が弾性封止剤により封止され、上記ケースの下面開口部が、上記積層体の主面電極と内部電極とに接続される外部接続用電極を有する裏蓋で閉じられていることを特徴とする請求項１ないし４のいずれかに記載の圧電型電気音響変換器。

【請求項６】上記積層体は矩形板状に形成され、上記積層体が、上面に開口部を有し、上記積層体の主面電極と内部電極とに接続される外部接続用電極を有するケースに収容され、上記積層体の対向する２辺が、上記ケースの内側面対向部に形成された支持部に支持剤により固定され、上記積層体の他の２辺と上記ケースの内面との間の隙間が弾性封止剤により封止され、上記ケースの上面開口部が、放音穴を有する上蓋で閉じられていることを特徴とする請求項１ないし４のいずれかに記載の圧電型電気音響変換器。

【請求項７】上記積層体は矩形板状に形成され、上記積層体が、下面に開口部を有し上面に放音穴を有するケースに収容され、上記積層体の４辺が、上記ケースの内側面に形成された支持部に支持剤により固定され、上記ケースの下面開口部が、上記積層体の主面電極と内部電極とに接続される外部接続用電極を有する裏蓋で閉じられ

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ていることを特徴とする請求項１ないし４のいずれかに記載の圧電型電気音響変換器。

【請求項８】上記積層体は矩形板状に形成され、上記積層体が、上面に開口部を有し、上記積層体の主面電極と内部電極とに接続される外部接続用電極を有するケースに収容され、上記積層体の４辺が、上記ケースの内側面に形成された支持部に支持剤により固定され、上記ケースの上面開口部が、放音穴を有する上蓋で閉じられていることを特徴とする請求項１ないし４のいずれかに記載の圧電型電気音響変換器。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は圧電受話器、圧電サウンダ、圧電スピーカ、圧電ブザーなどの圧電型電気音響変換器、特にその振動板の構造に関するものである。

【０００２】

【従来の技術】従来、圧電受話器や圧電ブザーなどに圧電型電気音響変換器が広く用いられている。この種の圧電型電気音響変換器は、円形の圧電セラミック板の片面に円形の金属板を貼り付けてユニモルフ型振動板を構成し、この振動板の周縁部を円形のケースの中に支持し、ケースの開口部をカバーで閉鎖した構造のものが一般的である。しかしながら、ユニモルフ型振動板の場合、電圧印加によって外径が伸縮するセラミック板を、寸法変化しない金属板に接着して屈曲振動を得るものであるから、その変位量つまり音圧が小さいという欠点がある。

【０００３】そこで、複数の圧電セラミックス層からなる積層構造のバイモルフ型振動板が提案されている（特開昭６１－２０５１００号公報）。この振動板は、複数のセラミックグリーンシートおよび複数の電極を積層し、同時に焼成して得られた焼結体を利用したものであり、振動板の振動を拘束しない位置に形成されたスルーホールにより、電極間を電気的に接続している。そして、厚み方向に順に配置された第１および第２の振動領域が相互に逆方向に振動するように構成することで、ユニモルフ型に比べて大きな変位量つまり大きな音圧を得ることができる。

【０００４】

【発明が解決しようとする課題】ところが、上記バイモルフ型振動板の場合、例えば３層のセラミックス層からなる振動板を屈曲振動させようとすると、上記公報の第１７図に示すように、一方の主面の電極と一方の内部電極とをスルーホールを介して相互に接続し、他方の主面電極と他方の内部電極とをスルーホールを介して相互に接続した上、両者の間に交番電圧を印加する必要がある。そのため、主面電極と内部電極との間の複雑な相互接続が必要となり、コスト高になる可能性があった。

【０００５】また、上記積層体に対して分極処理を行なう場合も、内部電極と表裏の主面電極との間に電圧を印加して分極しなければならない。例えば３層構造の振動

板の場合、上記公報の第１４図に示すように、内部電極と導通する２個のスルーホールを接続用の電極でつなぎ、この接続用電極と表裏の主面電極との間に高電圧を印加して分極している。このように、従来のバイモルフ型振動板の場合、分極処理のために内部電極をスルーホールを介して外部に引き出す必要があり、接続用の電極を形成するなど、煩雑な処理を必要とするという欠点があった。

【０００６】そこで、本発明の目的は、主面電極と内部電極との相互接続をなくし、簡単な接続構造でバイモルフ型振動板を構成できる圧電型電気音響変換器を得ることにある。また、他の目的は、分極処理を簡単に行なうことができる圧電型電気音響変換器を得ることにある。

【０００７】

【課題を解決するための手段】上記目的を達成するため、請求項１に記載の発明は、２層または３層の圧電セラミックス層を積層して積層体が形成され、この積層体の表裏主面には主面電極が形成され、各セラミックス層の間には内部電極が形成され、すべてのセラミックス層は厚み方向において同一方向に分極されており、上記主面電極と内部電極との間に交番信号を印加することで、上記積層体は全体として屈曲振動を生じることを特徴とする圧電型電気音響変換器を提供する。

【０００８】本発明の積層体の場合、主面電極と内部電極との間に交番電圧を印加すれば、表側および裏側のセラミックス層に働く電界方向が厚み方向において逆方向になる。一方、分極方向は全てのセラミックス層が厚み方向において同一方向に向いている。圧電セラミックスは、分極方向と電界方向とが同一方向であれば平面方向に縮む性質を有し、分極方向と電界方向とが逆方向であれば平面方向に伸びる性質を有している。したがって、上記のように交番電圧を印加すれば、表側のセラミックス層が縮んだ時、裏側のセラミックス層が伸び、全体として積層体は屈曲振動を生じることになる。この変位量はユニモルフ型振動板に比べて大きくなるので、音圧も増大する。

【０００９】本発明では、表裏の主面電極を相互に接続し、これと内部電極との間に交番電圧を印加すれば、屈曲振動を発生させることができるので、従来のように主面電極と内部電極との間の複雑な相互接続が不要となり、構造が簡単になり、加工コストを低減できる。

【００１０】請求項２のように、内部電極を積層体の端面に形成された端面電極と接続し、上記端面電極と２つの主面電極との間に交番信号を印加するのが望ましい。この場合には、スルーホールなどの格別な加工を必要としない。

【００１１】請求項３のように、積層体が３層のセラミックス層で構成されている場合、中間のセラミックス層の厚みを積層体の全体の厚みの５０％～８０％とするのが望ましい。音圧を高めるには、積層体の積層数を増やせばよいが、共振周波数により厚みが固定されている場合には、積層数も自由に増やすことができない。３層構造の積層体の場合、２つの内部電極の間には電位差がないので、中間層は屈曲振動には寄与せず、表側および裏側のセラミックス層のみが屈曲振動することになる。セラミックス層はその厚みが薄い程、変位量が大きい。そこで、積層体の全体の厚みを一定とし、中間層の厚みを表裏層の厚みに対して相対的に厚くすると、屈曲振動に寄与する表側および裏側のセラミックス層の厚みが相対的に薄くなり、大きな変位量が得られる。なお、中間層の厚みを大きくし過ぎると、表裏層の厚みが薄くなり過ぎ、強度が低下して大きな変位が得られない。そこで、中間層の厚みを全体の５０％～８０％の範囲とすることで、大きな音圧を得ることができる。

【００１２】請求項４のように、積層体は電極膜を介して２層または３層のセラミックグリーンシートを積層し、同時に焼成して得られる焼結体よりなり、積層体の表裏主面に形成された主面電極間に電圧を印加することで、すべてのセラミックス層を厚み方向において同一方向に分極するのが望ましい。すなわち、予め焼成し分極処理したセラミック板を複数枚積層接着して積層体を得ることも可能であるが、これでは積層体の厚みを薄くできず、音圧が小さい。これに対し、セラミックグリーンシートを電極膜を間にして積層し、同時焼成すれば、非常に薄い積層体を得ることができ、高い音圧を得ることができる。しかも、積層体の各セラミックス層の分極方向が同一方向を向いているので、その分極処理は、従来のように内部電極と主面電極との間に電圧を印加する必要がなく、表裏の主面電極の間に電圧を印加するだけでよく、分極処理が非常に簡単になる。

【００１３】上記積層体をハウジング内に収容し、圧電受話器や圧電サウンダのような発音体として用いる場合、請求項５～８に記載のような構造とすることができる。すなわち、請求項５、６は受話器としての用途に適した例であり、広いレンジの周波数に対応するため、共振領域以外の領域で使用される。そのため、積層体の振動エネルギーが比較的小さいので、積層体の対向する２辺だけをケースに支持し、他の２辺は弾性封止体で変位自在に封止した構造となっている。一方、請求項７，８は圧電サウンダなどの用途に適した例であり、単一周波数での大音量に対応するため、共振領域で使用される。この場合には、積層体の振動エネルギーが非常に大きいので、積層体の４辺すべてをケースに支持した構造となっている。いずれの構造も、積層体の主面電極と内部電極とをリード線を使用せずにハウジングの外部に引き出すことができるので、表面実装部品として構成することができる。

【００１４】

【発明の実施の形態】図１，図２は本発明にかかる圧電型電気音響変換器の第１実施例を示す。この圧電型電気

音響変換器は、円板状の振動板（積層体）１と、この振動板１を収容した円形のケース１０および蓋１１とで構成されている。ケース１０の上面には放音穴１２が形成され、下面開口部に蓋１１が接着されている。ケース１０の外周部の対称位置には、外部接続用端子１３，１４がインサート成形などにて固定され、端子１３，１４の一部はケース１０の内側に露出している。端子１３，１４の内側露出部に、振動板１の電極が導電性接着剤１５，１６によって電気的に接続されている。なお、導電性接着剤１５，１６を塗布した箇所以外の振動板１の外周部とケース１０との隙間は、シリコーンゴムなどの弾性封止剤（図示せず）で封止されている。

【００１５】振動板１は、図３，図４に示すようにＰＺＴなどからなる２層の圧電セラミックス層２，３を積層したものであり、振動板１の表裏主面には主面電極４，５が形成され、セラミックス層２，３の間には内部電極６が形成されている。２つのセラミックス層２、３は、図４に太線矢印で示すように厚み方向において同一方向に分極されている。

【００１６】この実施例では、表側の主面電極４と裏側の主面電極５は、振動板１の直径よりやや小さい円形に形成され、その引出電極４ａ，５ａが振動板１の外周縁まで引き出されている。内部電極６は主面電極４、５とほぼ対称形状に形成され、内部電極６の引出電極６ａは上記引出電極４ａ，５ａとほぼ対称位置へ引き出され、端面に設けられた端面電極７に接続されている。なお、端面電極７の一部は振動板１の表裏面まで引き出されている。上記引出電極４ａ、５ａは導電性接着剤１５によって端子１３と接続され、端面電極７は導電性接着剤１６によって端子１４と接続されている。そして、端子１３、１４の間に所定の交番電圧を印加することで、振動板１を屈曲振動させることができる。

【００１７】例えば一方の端子１３にマイナスの電圧、他方の端子１４にプラスの電圧を印加すると、図４の細線矢印で示す方向の電界が生じる。セラミックス層２，３は、分極方向と電界方向とが同一方向であれば平面方向に縮む性質を有し、分極方向と電界方向とが逆方向であれば平面方向に伸びる性質を有するので、表側のセラミックス層２は縮み、裏側のセラミックス層３は伸びることになる。そのため、振動板１は中心部が下方へ凸となるように屈曲する。端子１３，１４に印加する電圧を交番電圧とすれば、振動板１は周期的に屈曲振動を生じ、これによって大きな音圧の音を発生することができる。

【００１８】上記構成よりなる振動板１は次のような方法で製造される。すなわち、マザー基板状態のセラミックグリーンシートの表面に電極膜を印刷などの手法で所定のパターンに形成し、このセラミックグリーンシート１枚と、電極膜を形成していないセラミックグリーンシート１枚とを積層して圧着する。次に、この積層体から振動板１に対応する形状に打ち抜き、あるいはカットする。次に、打ち抜きまたはカットされた積層体を同時焼成して焼結積層体を得る。次に、焼結積層体の表裏主面に主面電極を形成し、これら主面電極間に分極電圧を印加することで、積層体を構成する全てのセラミックス層を厚み方向において同一方向に分極する。その後、端面電極７などを形成し、振動板１を得る。

【００１９】上記製造方法では、積層されたマザー基板状態のセラミックグリーンシートを個別形状に打ち抜いた後、焼成し、その後で分極処理したが、積層されたセラミックグリーンシートを焼成した後、マザー基板状態で分極処理し、その後で個別形状にカットしてもよい。この場合には、焼結体をカットするために、レーザー加工などの公知の方法を用いればよい。

【００２０】図５，図６は本発明にかかる圧電型電気音響変換器の第２実施例を示す。図１、図２では、ケース１０に固定された端子１３、１４を用いて振動板１の電極を外部へ引き出したが、図５，図６ではリード線２０、２１を用いたものである。この場合には、リード線２０、２１が振動板１の裏面側の主面電極５と端面電極７とにそれぞれ半田や導電性接着剤などの接合剤２２，２３によって接続される。そのため、表裏の主面電極４、５を導電性接着剤を用いて相互に接続してもよいし、予め端面電極によって主面電極４、５を接続しておいてもよい。

【００２１】図７，図８は本発明にかかる圧電型電気音響変換器の第３実施例を示す。この圧電型電気音響変換器は、長方形の振動板（積層体）３０と、この振動板３０を収容した角形のケース４０および蓋４１とで構成されている。ケース４０の上面には放音穴４２が形成され、下面開口部に蓋４１が接着されている。ケース４０の対向する２辺の内側面には段差状の支持部４２ａ，４２ｂが形成され、これら支持部４２ａ，４２ｂ上に振動板３０の短辺側の２辺が接着剤などの支持剤４３ａ，４３ｂによって支持されている。ケース４０の支持部４２ａ、４２ｂを設けた側面とは異なる側面には、制動孔４８が形成されている。また、振動板３０の長辺側の２辺とケース４０との隙間はシリコーンゴムなどの弾性封止剤４４ａ，４４ｂによって封止されている。蓋４１の両端部表裏面には外部接続用電極４５ａ，４５ｂが形成されており、表裏の電極４５ａ，４５ｂは蓋４１の両端部側縁に形成されたスルーホール溝４６ａ、４６ｂの内面を介して相互に導通している。

【００２２】蓋４１をケース４０の下面開口部に接着した後、図８に示すようにスルーホール溝４６ａ、４６ｂから導電性接着剤４７ａ、４７ｂを流し込むことで、外部接続用電極４５ａ，４５ｂと振動板３０の電極とが相互に接続されるとともに、スルーホール溝４６ａ，４６ｂが閉じられる。これにより、圧電型電気音響変換器が完成する。

【００２３】この実施例の振動板３０は、図９、図１０に示すように、２層の圧電セラミックス層３１、３２を積層したものであり、振動板３０の表裏主面には主面電極３３，３４が形成され、セラミックス層３１、３２の間には内部電極３５が形成されている。２つのセラミックス層３１，３２は、図１０に太線矢印で示すように厚み方向において同一方向に分極されている。

【００２４】この実施例では、表側の主面電極３３と裏側の主面電極３４は、振動板３０の短辺と同幅でかつ長辺よりやや短く形成され、その一端は振動板３０の一方の短辺側端面に形成された端面電極３６に接続されている。そのため、表裏の主面電極３３、３４は相互に接続されている。内部電極３５は主面電極３３，３４とほぼ対称形状に形成され、内部電極３５の一端は上記端面電極３６と離れており、他端は振動板３０の他方の短辺側端面に形成された端面電極３７に接続されている。なお、振動板３０の他方の短辺側端部の上下面には、端面電極３７と導通する細幅な補助電極３８が形成されている。

【００２５】上記端面電極３６または裏側の主面電極３４は、図８のように導電性接着剤４７ａによって外部接続用電極４５ａと接続され、端面電極３７は導電性接着剤４７ｂによって外部接続用電極４５ｂと接続されている。そして、外部接続用電極４５ａ、４５ｂの間に所定の交番電圧を印加することで、振動板３０を長さベンディングモードで屈曲振動させることができる。すなわち、振動板３０の短辺側両端部を支点とし、長手方向の中央部を最大振幅点として屈曲振動させることができる。

【００２６】第１実施例のような円形振動板１の場合には、中心部のみが最大振幅点となるため、変位体積が小さく、音響変換効率が比較的低い。また、振動板１の周囲が拘束されるので、周波数が高くなり、低い周波数の圧電振動板を得ようとすれば、半径寸法が大きくなる。これに対し、第３実施例のような矩形振動板３０の場合には、最大振幅点が長さ方向の中心線にそって存在するので、変位体積が大きく、高い音響変換効率を得ることができる。また、振動板３０はその長さ方向両端部が固定されるが、その間の部分は弾性封止剤４４ａ、４４ｂによって自由に変位できるので、円形の振動板に比べて低い周波数を得ることができる。逆に、同じ周波数を得るのであれば、寸法を小型化できる。

【００２７】図１１は、図１０の変形例である。振動板の第４実施例を示す。図１０では内部電極３５が部分電極である例を示したが、図１１では全面電極としたものである。この場合には、内部電極３５が端面電極３６側まで延びているので、内部電極３５と端面電極３６とが導通してしまう恐れがある。そこで、振動板３０'の端面にまず絶縁層３９を形成し、その上に表裏の主面電極３３、３４を導通させる端面電極３６を形成したものである。これにより、内部電極３５を全面電極とした場合でも、内部電極３５と主面電極３３、３４とを確実に絶縁できる。

【００２８】図１２は振動板の第５実施例を示す。この実施例の振動板５０は、３層の圧電セラミックス層５１～５３を積層したものであり、振動板５０の表裏面には主面電極５４、５５が形成され、各セラミックス層５１～５３の間には内部電極５６，５７が形成されている。３つのセラミックス層５１～５３は太線矢印で示すように厚み方向において同一方向に分極されている。

【００２９】この実施例の主面電極５４，５５は、図１０と同様に振動板５０の短辺と同幅でかつ長辺よりやや短く形成され、その一端は振動板５０の一方の短辺側端面に形成された端面電極５８に接続されている。そのため、表裏の主面電極５４、５５は相互に接続されている。内部電極５６，５７の一端は端面電極５８と離れており、他端は振動板５０の他方の短辺側端面に形成された端面電極５９に接続されている。したがって、内部電極５６，５７も相互に接続されている。なお、振動板５０の他方の短辺側端部の上下面には、端面電極５９と導通する細幅な補助電極５９ａが形成されている。

【００３０】例えば、端面電極５８にマイナスの電圧、端面電極５９にプラスの電圧を印加すると、図１２の細線矢印で示す方向の電界が生じる。この時、中間層であるセラミックス層５２の両側に位置する内部電極５６，５７は同一電位であるため、電界が生じない。表側のセラミックス層５１は分極方向と電界方向とが同一方向であるため平面方向に縮み、裏側のセラミックス層５２は分極方向と電界方向とが逆方向であるため平面方向に伸びる。そして、中間層５２は伸び縮みしない。そのため、振動板５０は下方へ凸となるように屈曲する。端面電極５８，５９間に交番電圧を印加すれば、振動板５０は周期的に屈曲振動を生じ、これによって大きな音圧の音を発生することができる。なお、図１２では、内部電極５６，５７を部分電極としたが、図１１のように全面電極としてもよい。

【００３１】上記のような３層構造の振動板５０の製造方法も、図４に示した２層構造の振動板１の製造方法と同様である。すなわち、マザー基板状態のセラミックグリーンシートの表面に電極膜を印刷などの手法で所定のパターンに形成し、このセラミックグリーンシートを３枚積層して圧着する。この積層体から振動板５０に対応する形状に打ち抜きまたはカットし、この打ち抜きまたはカットされた積層体を同時焼成して焼結積層体を得る。次に、焼結積層体の表裏面に主面電極５４，５５を形成し、これら主面電極間に分極電圧を印加することで、積層体を構成する全てのセラミックス層５１～５３を厚み方向において同一方向に分極する。その後、端面電極５８，５９などを形成することで、振動板５０を得る。この場合も、分極に際し、内部電極５６，５７と主

面電極５４，５５とを相互に接続する必要がなく．表裏の主面電極５４．５５間に電圧を印加するだけでよいので．分極処理が簡単である。

【００３２】図１３は振動板の第６実施例を示す。図１２の実施例では３層のセラミックス層５１～５３がほぼ同一厚みである例を示したが、図１３では中間のセラミックス層５２を表裏のセラミックス層５１，５３に比べて厚くしたものである。特に、中間のセラミックス層５２の厚みは、振動板５０' の全体の厚みの５０％～８０％とするのが望ましい。なお、他の構造は図１２と同様であるため、重複説明を省略する。

【００３３】図１４は中間セラミックス層５２の厚みの割合を変化させた時の音圧の変化を示す。縦軸は２層構造の振動板（図１０参照）の音圧を１とした時の音圧の比率であり、横軸は振動板５０' の全体の厚みに対する中間セラミックス層５２の厚みの割合を表す。なお、音圧は．振動板５０' の全体の厚みが一定で、かつ印加電圧が一定である条件で測定した。

【００３４】図１４から明らかなように、２層に比べて３層の場合には音圧が上昇することが分かる。また、３層すべてが同一厚みである場合（３３％）に比べて、中間層の厚みを全体の５０％～８０％とした場合には、さらに音圧が上昇する。特に．中間層の厚みを全体の６０％～７０％とした場合に最大の音圧（２層に比べて１．６倍）を得ることができる。したがって、積層数に制約がある場合に．中間層の厚みを大きくすることで．積層数を少なく（３層）しながら、音圧を最大限まで上げることができる。

【００３５】図１５～図１７は本発明にかかる圧電型電気音響変換器の第７実施例であり、表面実装型の圧電受話器として構成した例を示す。この圧電受話器は．大略．長方形の振動板（積層体）３０と．この振動板３０を収容した角形のケース６０と、放音孔６９を有する上蓋６８とで構成されている。振動板３０は図９、図１０に示されたものと同様であるため、同一符号を付してある。ケース６０は、例えばＬＣＰ（液晶ポリマー），ＳＰＳ（シンジオタクチックポリスチレン），ＰＰＳ（ポリフェニレンサルファイド），エポキシなどの耐熱性樹脂で形成され．上蓋６８も液晶ポリマーまたはガラスエポキシなどの耐熱性材料あるいはセラミックスで形成されている。ケース６０の上面には開口部６１が形成され．この上面開口部６１に上蓋６８が接着されている。ケース６０の対向する２辺の内側面には段差状の支持部６２ａ，６２ｂが形成され．これら支持部６２ａ．６２ｂの上面とケース６０の外側面とに露出するように、外部接続用電極６３ａ，６３ｂがインサート成形されている。この外部接続用電極６３ａ，６３ｂとしては．例えばＡｕ，Ｓｎメッキを施したＣｕ合金．Ｆｅなどからなる金属端子で構成される。ケース６０の支持部６２ａ，６２ｂを設けた側面とは異なる側面には、制動孔６４が形成されている。

【００３６】振動板３０の短辺側の２辺は、支持部６２ａ．６２ｂ上に接着剤などの支持剤６５ａ，６５ｂによって支持されている。また．振動板３０の長辺側の２辺とケース６０との隙間はシリコーンゴムなどの弾性封止剤６６ａ，６６ｂによって封止されている。そして、振動板３０の短辺側の２辺に設けられた端面電極３６，３７は．導電ペースト６７ａ．６７ｂによって支持部６２ａ．６２ｂの上面に露出した外部接続用電極６３ａ，６３ｂとそれぞれ電気的に接続されている。なお．支持剤６５ａ，６５ｂおよび弾性封止剤６６ａ，６６ｂの塗布は．導電ペースト６７ａ．６７ｂによって振動板３０と外部接続用電極６３ａ，６３ｂとを接着した後で行う方がよい。そして．導電ペースト６７ａ．６７ｂ．支持剤６５ａ，６５ｂおよび弾性封止剤６６ａ，６６ｂの加熱硬化は、同時に行ってもよい。

【００３７】図１８は本発明にかかる圧電型電気音響変換器の第８実施例であり．図１５～図１７に示された例の変形例である。この実施例では、外部接続用電極６３ａ．６３ｂが．ケース６０にインサートされたものではなく．別体に形成された金属端子をケース６０の孔６０ａに挿入し、接着したものである。その他の構造は図１５～図１７と同様であるから、同一部品には同一符号を付して説明を省略する。

【００３８】図１９～図２１は本発明にかかる圧電型電気音響変換器の第９実施例であり、表面実装型部品として構成した例を示す。この実施例では．図１５～図１７におけるインサート端子よりなる外部接続用電極６３ａ．６３ｂに代えて、無電解湿式めっき法あるいはスパッタなどの乾式めっき法により形成した電極膜６３ｃ，６３ｄとしたものである。この例では．電極膜６３ｃ，６３ｄがケース６０の支持部６２ａ．６２ｂを設けた側部の外面から支持部６２ａ．６２ｂの上面にかけて連続的に形成されている。その他の構成は図１５～図１７のものと同様であるから、同一部品には同一符号を付して説明を省略する。

【００３９】なお、図１５～図２１に示す実施例において．振動板としては、図９．図１０に示された振動板３０に限らず、図１１，図１２，図１３に示された振動板３０' ，５０．５０' を用いることも可能である。

【００４０】図２２は本発明にかかる圧電型電気音響変換器の第１０実施例である。この実施例は、図７に示す実施例の変形例であり、図７と同一部分には同一符号を付して説明を省略する。図２２は裏側から見た斜視図であり．ケース４０' の内側面全周に段差状の支持部４２が形成されている。これら支持部４２の頂面は同一高さに形成されており、支持部４２上に振動板３０の４辺全周が接着剤などの支持剤４３によって支持されている。この実施例は．例えば圧電サウンダなどの単一周波数での発音器として用いられるものであり．振動板３０の全

周が支持剤４３によって拘束されるが、振動板３０を共振領域で使用することにより、強く励振させることができ、大音量を得ることができる。

【００４１】図２３は本発明にかかる圧電型電気音響変換器の第１１実施例である。この実施例は、図１５～図１７に示す実施例とほぼ同様な構造を有し、図１５～図１７と共通部分には同一符号を付して説明を省略する。この実施例では、角形のケース６０の内側面全周に段差状の支持部６２が形成され、振動板３０の４辺すべてが支持部６２に対して接着剤などの支持剤６５によって支持されている。この実施例も、圧電サウンダなどの単一周波数での発音器として用いられる例であり、振動板３０は共振領域で使用される。

【００４２】本発明は上記実施例に限定されるものではなく、本発明の趣旨を逸脱しない範囲で種々変更が可能である。上記実施例では、振動板の端面に内部電極と導通する端面電極を形成し、この端面電極を介して外部へ引き出すようにしたが、これに限るものではない。すなわち、特開昭６１－２０５１００号公報のようにスルーホールを介して内部電極を外部へ引き出してもよいし、スリット状の溝あるいは穴を介して外部へ引き出してもよい。上記実施例の振動板１，３０，３０′，５０，５０′の製造方法は、セラミックグリーンシートを電極膜を介して２枚または３枚積層し、この積層体を同時焼成して焼結積層体を得た後、この焼結積層体を分極処理するものであるが、この方法に代えて、予め焼成し分極処理した２枚または３枚の圧電セラミックス板を積層接着してもよい。ただし、積層後に焼成する前者の製造方法は、予め焼成したものを積層する後者の方法に比べて、振動板の厚みを格段に薄くでき、音圧を大きくできるので、前者の製造方法の方が音響変換効率に優れた振動板を得ることが可能である。本発明の振動板は、圧電セラミックス層のみで構成されたものに限らず、積層体の片面に金属フィルムや樹脂シートなどの補強シートを貼り付けてもよい。但し、この補強シートはユニモルフ型振動板の金属板とは異なり、積層体の割れなどを防止するためのものであり、積層体の屈曲振動を阻害しないものが望ましい。

【００４３】

【発明の効果】以上の説明で明らかなように、請求項１に記載の発明によれば、２層または３層の圧電セラミックス層からなる積層体の表裏面に主面電極を形成し、各セラミックス層の間に内部電極を形成し、すべてのセラミックス層を厚み方向において同一方向に分極したので、主面電極と内部電極との間に交番信号を印加すれば、表側と裏側のセラミックス層が逆方向に伸縮し、全体として積層体が屈曲振動を生じることになる。この変位量はユニモルフ型振動板に比べて大きくなるので、音圧も増大する。また、すべてのセラミックス層が厚み方向において同一方向に分極されているので、従来のような主面電極と内部電極との間の複雑な相互接続が不要であり、主面電極と内部電極との間に交番信号を印加するだけでよく、構造が簡単で、製造コストを低減できる。

【図面の簡単な説明】

【図１】本発明にかかる圧電型電気音響変換器の第１実施例の外観斜視図である。

【図２】図１に示す圧電型電気音響変換器の縦断面図である。

【図３】図１の圧電型電気音響変換器に用いられる振動板の斜視図である。

【図４】図３に示す振動板の縦断面図である。

【図５】本発明にかかる圧電型電気音響変換器の第２実施例の外観斜視図である。

【図６】図５に示す圧電型電気音響変換器の縦断面図である。

【図７】本発明にかかる圧電型電気音響変換器の第３実施例を裏側から見た分解斜視図である。

【図８】図７の圧電型電気音響変換器の断面図である。

【図９】図７の圧電型電気音響変換器に用いられる振動板の斜視図である。

【図１０】図９の振動板の断面図である。

【図１１】本発明にかかる振動板の第４実施例の断面図である。

【図１２】本発明にかかる振動板の第５実施例の断面図である。

【図１３】本発明にかかる振動板の第６実施例の断面図である。

【図１４】図１３に示す振動板を用いた圧電型電気音響変換器の中間層の厚みと音圧との関係を示す特性図である。

【図１５】本発明にかかる圧電型電気音響変換器の第７実施例の斜視図である。

【図１６】図１５に示す圧電型電気音響変換器の分解斜視図である。

【図１７】図１５のＡ－Ａ線断面図である。

【図１８】本発明にかかる圧電型電気音響変換器の第８実施例の分解斜視図である。

【図１９】本発明にかかる圧電型電気音響変換器の第９実施例の斜視図である。

【図２０】図１９に示す圧電型電気音響変換器の分解斜視図である。

【図２１】図１９のＢ－Ｂ線断面図である。

【図２２】本発明にかかる圧電型電気音響変換器の第１０実施例の分解斜視図である。

【図２３】本発明にかかる圧電型電気音響変換器の第１１実施例の分解斜視図である。

【符号の説明】

１，３０，３０′，５０，５０′　振動板

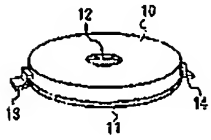
２，３，３１，３２，５１～５３　セラミックス層

４，５，３３，３４，５４，５５　主面電極

13　　14

6，35，56，57	内部電極	＊65a，65b	支持剤
10，60	ケース	66a，66b	弾性封止剤
11	裏蓋	67a，67b	導電ペースト
62a，62b	支持部	68	上蓋
63a，63b	外部接続用電極	＊ 69	放音穴

【図１】



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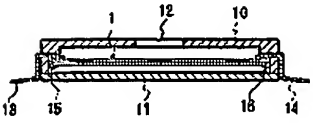

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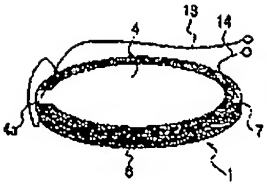

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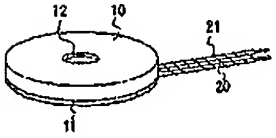

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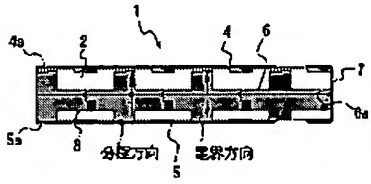

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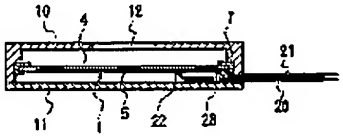

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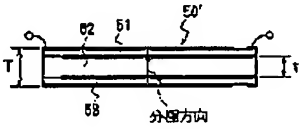

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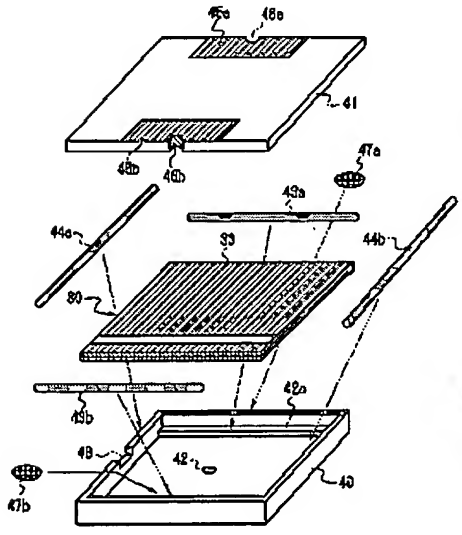

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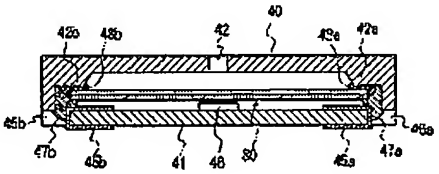

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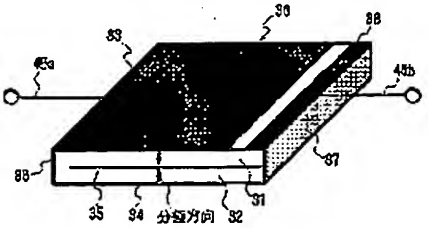

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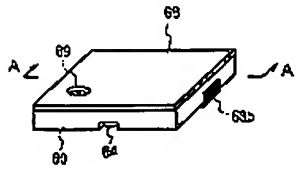

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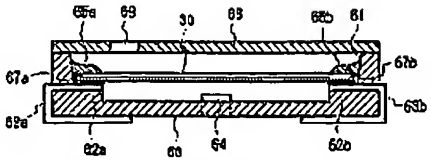

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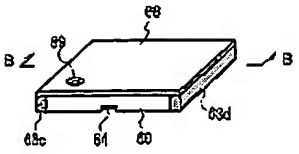

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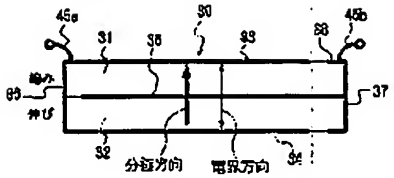

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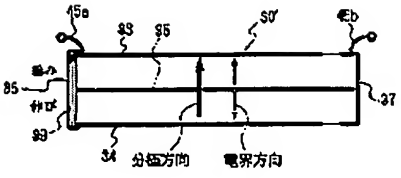

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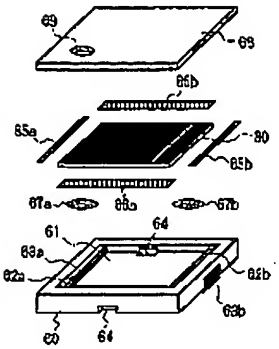

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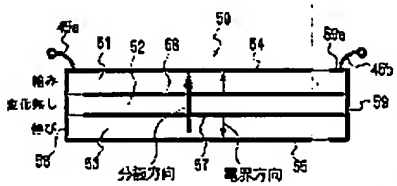

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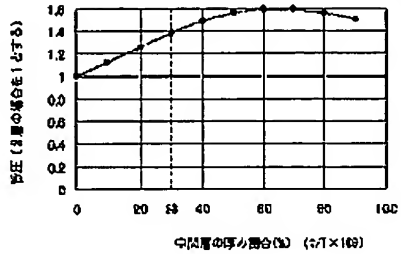

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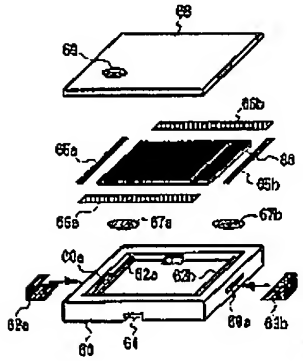

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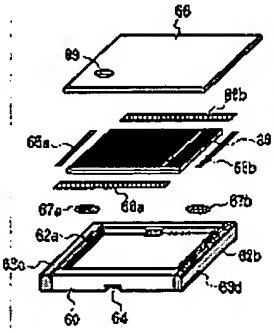

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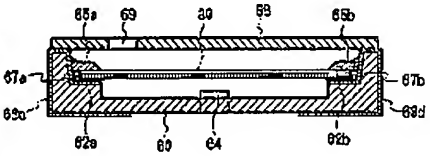

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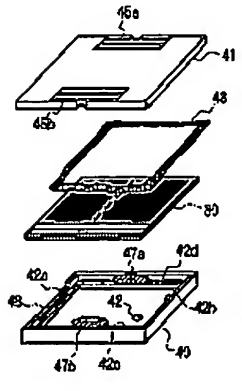

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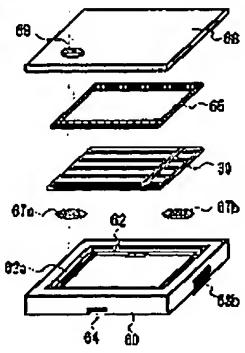

【手続補正書】
【提出日】平成１２年７月１８日（２０００．７．１８）
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】００１３
【補正方法】変更
【補正内容】
【００１３】上記積層体をハウジング内に収容し、圧電受話器や圧電サウンダのような発音体として用いる場合、請求項５～８に記載のような構造とすることができる。すなわち、請求項５、６は受話器としての用途に適した例であり、広いレンジの周波数に対応するため、共＊振領域以外の領域も使用される。そのため、積層体の振動エネルギーが比較的小さくても変位できるように、積層体の対向する２辺だけをケースに支持し、他の２辺は弾性封止体で変位自在に封止した構造となっている。一方、請求項７、８は圧電サウンダなどの用途に適した例であり、単一周波数での大音量に対応するため、共振領域で使用される。この場合には、積層体の振動エネルギーを大きくするため、積層体の４辺すべてをケースに支持した構造となっている。いずれの構造も、積層体の主面電極と内部電極とをリード線を使用せずにハウジングの外部に引き出すことができるので、表面実装部品として構成することができる。

フロントページの続き

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